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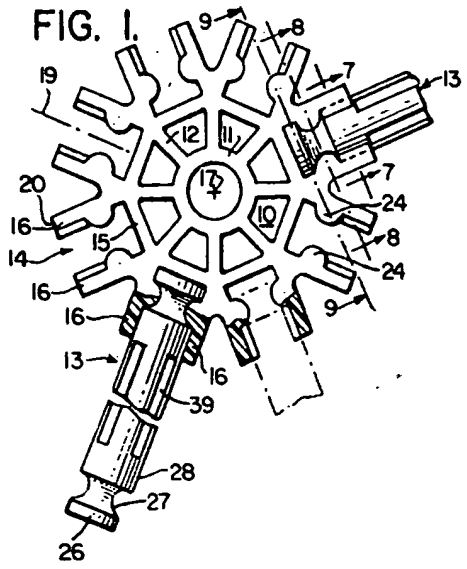
(54) Construction toy.

(57) A construction toy system uses, as principle components, a connector (10) having one or more gripping sockets (14), and rod-like struts (13) having end portions configured to be received in the gripping sockets (14). The sockets (14) comprise pairs of gripping arms (16), formed of deflectable plastic material. Outer portions of the gripping arms (16) have concave grooves for lateral, snap-in assembly of struts (13) having complimentary cylindrical connector portions. The gripping arms (16) have locking projections (24) arranged to interlock with annular recesses (27) near the ends of the struts (13). The struts (13) have end flanges (26), received in a cavity at the closed end of the gripping socket (14). Certain forms of the connecting elements are designed so that an assembly of two such connector elements provides for sockets in each of two planes oriented at right angles to each other to form a right angle corner structure, for example, or a Tee-shaped structure. The system comprises a variety of connector elements, having one or more sockets arranged to be joined with struts, to form complex structural units. A plurality of single socket connector elements can be connected with a succession of crosswise oriented struts to form an articulated structure, of endless or finite length. Connector elements also may be joined to form connector assemblies with provision for mounting struts in several planar directions, Struts are provided in graduated sizes according to a predetermined length progression, such that one standard size strut can serve as the hypotenuse of a right isosceles triangle formed with struts of a smaller size. Complex structures can be assembled using right triangular subunits. The device is especially adapted for high volume production by injection molding techniques.

FIG. 1.



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Background and Summary of the Invention

The present invention is directed to construction toys, and more particularly to a novel and improved form of construction toy, comprising hub-like connector elements and strut-like structural elements adapted to be removably engaged with the connector elements to form a composite structure.

A variety of construction toys is known, which are comprised of combinations of connector elements and structural elements which can be combined in various forms to form composite structures.

The device of the present invention, while being of a known general type, incorporates a variety of unique and advantageous features which greatly enhance its performance. At the same time, the device is designed to be mass produced by injection molding techniques, so as to be capable of manufacture on a low cost basis.

A hub-like connector element is provided with a plurality of generally radially oriented sockets for receiving and lockingly engaging end portions of typical structural elements of strut-like configuration. The connecting sockets are designed to accommodate lateral snap-in insertion of the structural elements. The end extremities of the structural elements are formed with an annular groove, defining a flanged end. The sockets on the connector elements are defined by spaced pairs of gripping arms, and each arm includes an inwardly protruding locking projection arranged to be received in the annular groove of the structural element. Accordingly, upon lateral snap-in installation of a structural element, it is locked against axial withdrawal from the connector element.

The strut-like structural elements, molded to be of circular cross section at the ends, are configured, in regions intermediate the ends in a generally X-shaped cross section. The X-shaped cross section is arranged for cooperation with the opposed locking projections of the gripping arms such that, when the structural element is oriented at 90° to its "normal" radial orientation in the connector element, it may be pressed laterally between a pair of gripping arms and snapped into locked position, with the locking projections engaging the X-shaped cross section to immobilize the structural element.

Among the structural possibilities enabled by the last mentioned feature of crosswise gripping of structural elements is the assembly of articulated belt-like structures, which can be incorporated into dynamically operated toy structures, such as bulldozers, tanks, conveyor belts and the like, and also static structures such as catenary suspension elements.

One form of connector element enables one connector to be joined with another, in planes which are disposed at right angles to each other. A pair of thus-joined connector elements provides for an assembly with structural elements in two principal planes. In addition, each of the available sockets still retains the ability to lockingly receive structural elements oriented at right angles to the principal plane of the hub-like connector element. In one modification, an assembly of connector elements can be provided which accommodates the mounting of strut elements extending in four planar directions from a central axis. Modified forms of such connector element assemblies are provided in which strut elements extend in three planar directions (forming a Tee-shaped joint) or in two planar directions (forming a right angular corner joint).

The design and construction of the socket-forming recesses, on the one hand, and the ends of the strut elements, on the other hand, advantageously is such that the cooperative action of the rib and groove means serves to yieldably urge the strut elements axially into tight end face contact with the end wall of the recess. This provides for a significant degree of additional stability in the connection between the strut and connector.

To particular advantage, the construction toy system includes a series of struts of graduated lengths, graduated in accordance with a predetermined formula such that when two struts of a given length in a series are joined with connector elements to form a right angularly related structure, the strut of the next larger length in the series is of an appropriate length to be joined in the assembly along the hypotenuse of the triangular structure. In this manner, a large structural assembly may be formed utilizing rigid triangular structural subassemblies of various different sizes for maximum strength and rigidity.

In the new system, in which a series of strut elements of graduated lengths is provided according to the before- mentioned principle, a structure consisting of a pair of like strut elements of a given length in the series, mounted on opposite sides of a connector element so as to be coaxial, are equal in length to the length of a strut element two sizes larger in the series. This arrangement provides for an extraordinary degree of flexibility in the arrangement of structural parts in any assembly.

A significant aspect of the foregoing geometric relationship is the fact that the strut elements can be assembled with the connector elements by lateral snap-in assembly, so that the center to center distance of a pair of connector elements does not have to be enlarged in order to receive a strut element. This enables a structure to be easily added to and/or modified even after it has reached a stage of substantial rigidity.

For many dynamic structures, a driving relationship between a strut element, functioning as an axle, and an associated connector element may be desired. To this end, the construction toy system incorporates a drive element comprising a socket-forming recess of the type described, which is intended for the crosswise reception of a strut element functioning as an axle for an adjacent connector element. The drive element is formed with a laterally extending drive pin arranged to be received between adjacent spoke-like webs of a connector element, in order to lock the connector element in driving relation to the strut on which it is supported.

For a more complete understanding of the above and other features and advantages of the invention, reference should be made to the following detailed description of preferred embodiments and to the accompanying drawing.

Description of the Drawing

Fig. 1 is an elevational view, partly in section, of a hub-like connector element constructed according to the invention, with selected structural elements joined therewith.

Fig. 2 is a greatly enlarged, fragmentary, perspective view of a portion of the connector element of Fig. 1.

Fig. 3 is an enlarged, fragmentary view of the end portion of a strut-like structural element constructed in accordance with the invention.

Fig. 4 is a cross sectional view as taken on line 4-4 of Fig. 3.

Figs. 5, 6 and 7 are sequential views, as taken generally on line 7-7 of Fig. 1, showing progressive stages of lateral, snap-in insertion of a structural element into a socket of the connector element of Fig. 1.

Figs. 8 and 9 are enlarged, cross sectional views as taken generally on lines 8-8, 9-9 respectively of Fig. 1.

Fig. 10 is an elevational view of a strut-like structural element constructed according to the invention.

Fig. 11 is a highly enlarged, fragmentary perspective view showing the structural element of Fig. 10 installed in a socket of a connector element at right angles to the normal radial orientation.

Fig. 12 is a transverse cross sectional view as taken generally on line 12-12 of Fig. 11.

Fig. 13 is a bottom perspective view of an adapter block element, for integrating the construction toy with certain popular, block-type construction toys.

Fig. 14 is an elevational view, partly in section, of the adapter block of Fig. 13.

Fig. 15 is a top plan view of the assembly of Fig. 14.

Fig. 16 is a perspective view of an assembly of a pair of modified connector elements each with the other.

Fig. 17 is an exploded view showing the component elements of the assembly of Fig. 16.

Fig. 18 is a greatly enlarged, fragmentary perspective view of a connector element of Fig. 16.

Fig. 19 is an elevational view of the assembly of Fig. 16.

Fig. 20 is an enlarged, fragmentary sectional view, illustrating the manner in which a structural element of Fig. 16 is inserted in certain of the sockets of the connector element.

Fig. 21 is a side elevational view of a single socket connector element constructed to receive one strut element oriented axially in a socket-forming recess and a second strut element in a hub bearing, disposed at right angles thereto.

Fig. 22 is a side elevational view of a two element connector.

Figs. 23-29 illustrate other modifications of connector elements.

Fig. 30 is a group view illustrating a series of strut elements of graduated length and also the relationship of the length of a given strut of a series to smaller struts joined together coaxially by a connecting element.

Fig. 31 is a greatly enlarged view illustrating the socket portion of a connecting element in cross section as joined with a strut element.

Fig. 32 is an elevational view of an assembly of strut and connector elements arranged in triangular subunits of increasing size.

Fig. 33 is a top plan view of an articulated belt or tread structure constructed of a plurality of single unit connectors and a plurality of strut elements mounted in crosswise relation therein.

Fig. 34 is a cross sectional view as taken along line 34-34 of Fig. 33.

Figs. 35-39 are various views illustrating a modified form of connector element which is capable of assembly with a like connector element.

Figs. 40, 41 illustrate a connector element of the type shown in Figs. 35-39, as assembled with a connector element of the type shown in Figs. 16-20.

Fig. 42 is a perspective view of a drive element constructed for crosswise reception of a strut element serving as an axle, and provided with a driving lug.

Fig. 43 is an elevational view of the driving element of Fig. 42, showing a strut element gripped in crosswise relation therein.

Fig. 44 is a view, similar to Fig. 43, showing in addition a connector element received on the strut element and drivingly engaged for rotation therewith.

Fig. 45 is an elevational view of a combined pulley and wheel-forming element.

Fig. 46 is a side elevational view of a tire-like element adapted for assembly with the element of Fig. 45.

Figs. 47, 48 are cross sectional views as taken generally on lines 47-47, 48-48 respectively of Figs. 45, 46.

Description of Preferred Embodiments

Referring now to the drawing, the reference numeral 10 designates a hub-like connector element 10, shown particularly in Fig. 1. The connector element includes a central hub cylinder 11 and radiating spokes 12. The illustrated form provides for the connection of eight, radially disposed structural elements, generally designated by the reference numeral 13.

The radial spokes 12 support an array of eight sockets 14, each comprising an end wall 15 and spaced-apart, opposed gripping elements 16. The sockets 14 are radially disposed with respect to the central axis 17 of the connector, and the respective pairs of gripping elements 16 are desirably arranged on opposite sides of the radial axis of the socket, in generally parallel relation to such radial axis.

The gripping elements 16 are provided in their outer portions with concave grooves 18, which are concentric about the radial axis 19 of the socket and extend from the outer end extremities 20 of the gripping elements a suitable distance toward the base wall 15 of the socket, typically about halfway.

The strut-like structural elements 13 are of generally cylindrical construction at the their end extremities. The structural elements may have a nominal diameter of, for example, approximately 0.250 inch, for cooperation with concave grooves 18 in the gripping elements formed on a diameter of the same dimension.

As is apparent in Fig. 5, the arc of the grooves 18 serves to narrow the entrance area 21 to a dimension significantly less than the 0.250 inch diameter of the structural element. The dimension at the throat or opening 21 may be on the order 0.210 inch. Accordingly, it is desirable to form the lateral edges 22 of the gripping arms to diverge from the throat 21 to the outer lateral surface 23 of the gripping arm. An angle of divergence of about 15° is appropriate. This facilitates the lateral insertion of the structural element 13 into the grooves 18 by causing the gripping arms 16 to be laterally displaced and separated. Once the connecting element is seated in the grooves 18, the gripping arms 16 close snugly about the structural element to retain it in position.

Each of the gripping arms 16 is provided with a locking projection 24, desirably of semicylindrical configuration, extending at right angles to the radial axis of the socket defined by the gripping elements. In the illustrated construction, the projections 24 are of generally uniform cross section and extend from one side edge of the gripping arms 16 to the other, as shown best in the enlarged perspective view of Fig. 2.

The locking projections 24 are spaced radially outward a short distance from the base wall 15 of the socket and define therewith a flange-receiving recess 25 at the inner or base end of the socket.

As shown in Fig. 3, the end extremity of each of the structural elements 13 is configured such that a longitudinal cross section of the end portion is approximately the same as the longitudinal cross section of a socket 14, taken along its radial axis in a plane parallel to the flat sides of the connector element. The structural elements 13 include cylindrical end flanges 26 of a size and shape to be received in the flange recess 25 of the socket. Immediately adjacent the cylindrical end flange 26 is an annular recess 27 of a semicircular cross sectional configuration adapted to be received within the narrowed space between opposed locking projections 24. Immediately adjacent the annular groove 27 is a cylindrical gripping portion 28, which is adapted to be received in the concave grooves 18 and gripped snugly by the outer portions of the gripping arms 16. The axial length of the gripping portion 26 desirably corresponds to the effective length of the grooves 18. The cylindrical flange 26 may have an axial length of, for example, 0.62 inch. The annular groove 27 and the locking projections 24 may have a typical radius of approximately 0.62 inch. For structural elements of 1/4 inch nominal diameter, a suitable length overall for the gripping sockets 14 is about 0.35 inch.

A typical form of strut-like structural element 13 is shown in Fig. 10. The element may of course be of any length, and a typical construction toy set incorporating principles of the invention would utilize large numbers of such elements, of various appropriate lengths. To particular advantage, portions of the structural element between its respective end portions 30 are of an X-shaped cross sectional configuration, comprised of ribs 31, extending radially, typically at 90° angular intervals and preferably with the external surfaces 32 of the ribs lying on the cylindrical envelope of the element as defined by its cylindrical end portions.

By properly dimensioning the thickness 33 of the ribs 31, and slightly beveling the outer sidewall portions thereof, as indicated at 34, the structural element is able to be pushed laterally into the open end of a radial socket 14 and forced between a pair of opposed locking projections 24, as reflected in Figs. 11 and 12, seating the projections in recesses

39 between adjacent ribs.

The X-shaped cross section of the structural element may be periodically interrupted by one or more pairs of cylindrical portions 35 spaced apart a distance approximately equal to the width dimension 36 of the gripping arms 16. When the structural element is snapped into locked position on the projections 24, as shown in Figs. 11 and 12, the structural element is locked in position axially, laterally and rotationally. Alternatively, if the structural element is applied laterally into the radial socket 14 in one of its areas 37 in which adjacent cylindrical sections 35 are widely spaced, it is possible to adjust the position of the structural element along its axis, within limits.

In a specifically advantageous embodiment of the invention, the width of the ribs 31 may be on the order of 0.93 inch, tapered convergently in the outer portions, as is reflected particularly in Fig. 4. It will be understood that "X-shaped" configuration of the structural elements 13 is not limited in principle to the use of two pairs of ribs. For example, three pairs of ribs may be arranged at 60° angular spacing. Accordingly, the term "X-shaped", as used herein is to be interpreted as encompassing such alternatives.

As reflected in Figs. 13-15, the present invention provides an adapter element, generally designated by the reference numeral 40, of block-like configuration, which is adapted to interface between conventional block-type construction elements and the construction toy elements of the present invention.

In Figs. 14 and 15, for example, elements 41, 42 are block-like construction elements of a known type, constructed in the form of an open-sided block provided with a "top" wall 44 and sidewalls 45-48 forming an open cavity 49. The top wall 44 is provided with a plurality (eight in the illustration) of short circular projections 50. Also extending from the top wall 44 through the cavity 49 are three elongated tubular friction posts 51. In accordance with known design of the block-type construction elements 41, 42, the internal dimensions of the cavity 49 are such as to fit snugly about the external projections 50. In addition, the friction posts 51 are dimensioned to have tangential contact with the sides of the projections 50 when construction blocks are placed one atop the other. This enables, in a known manner, the plurality of construction blocks to be frictionally assembled to form a composite structure.

The adapter block 40 includes a "top" wall 52 and sidewalls 53. In the illustrated arrangement, the adapter block is of square configuration, but other configurations are possible within the contemplation of the invention. Projecting from the top wall 52 are four elongated cylindrical projections 54 of a diameter and spacing corresponding to the short circular projections 50 of the construction blocks 41, 42. These cylindrical projections 54 may be inserted into the open cavity 49 of a construction block and desirably are of a length corresponding generally to the depth of the cavity 49.

A tubular adapter sleeve 55 extends from the underside of the "top" wall 52, through the open cavity 56 in the adapter block. The internal diameter of the tubular sleeve is such as to snugly receive an end portion 30 of a structural element 13, as shown in Fig. 14. The tubular sleeve 55 is recessed below the open edge 57 of the adapter block side walls so that the adapter block may be assembled with a conventional construction block in an otherwise known manner.

A connector element 70, shown in Figs. 16, 17, has the general "snowflake" configuration of the device described above, and has many of the structural features of the before mentioned device, but is specially modified to accommodate assembly with a second, similarly configured connector element oriented at right angles thereto. The connector element 70 is generally of a flat, open configuration, typically about 1/4 inch in thickness. At its center, the connecting element 70 has a solid, semi-cylindrical core 71. Guide walls 72, 13 extend from opposite sides of the core 71, in spaced-apart, parallel relation. The spacing between the guide walls 72, 73 is substantially equal to the thickness of the connector element, allowing for a second such element to be received within the recess 74 defined by the spaced-apart guide walls 72, 73 and a flat transverse wall 75 which forms one side of the core 71 and is positioned on an axial plane passing through the connector element.

Extending radially outward from the core are a plurality of spoke-like elements 76-78 which, at their outer ends, join with peripheral walls 79, 80. In the illustrated arrangement, the walls 79, 80 define seven sides of a generally octagonal structure, with the eighth side being open to accommodate the recess 74. As is evident in Fig. 17, the several walls 79 extend continuously from one spoke to the other (or from a spoke to the guide walls 72, 73). The wall 80, which lies directly opposite the recess 74 is, however, formed with a discontinuity 81 the function of which will be explained hereinafter.

Each of the walls 79, 80 forms the end wall of a strut-receiving socket 82 (in the case of the walls 79) or 83 (in the case of the interrupted wall 80). Each of the sockets is defined by pairs of opposed gripping elements 84 provided internally with a semi-cylindrical locking projections 85, which extend at right angles to the generally radial axis of the socket. The locking projections, in conjunction with the base walls 79, 80, define flange-receiving

recesses 86. The outer portions of the gripping elements 84 are formed with concave grooves 87 concentric with respect to the generally radial axis 88 of the socket.

As shown in Fig. 19, strut-like structural elements 90 are provided with cylindrical end flanges 91, adjacent annular grooves 92, and cylindrical portions 93 arranged to be received snugly in the concave grooves 87 of the gripping elements. The structural member 90 (sometimes referred to as a strut) normally is assembled with the connector element 70 by being pressed laterally into one of the recesses 82. The lateral entrance to the recess 82 is partially closed by a narrow throat section, defined by upper and lower edges 94 of the cylindrical grooves 87. Divergent guide surfaces 95 are provided to facilitate lateral insertion of the structural elements.

To particular advantage, the configuration of the sockets and struts is such that, when a strut end is received in a socket, the flat flange end wall 91a of the strut is resiliently urged into firm face to face contact with the flat base wall 79 (or 80) of the socket. This arrangement adds significant stability and rigidity to an assembly of parts. The desired relationship is achieved by displacing the locking flanges 85 slightly in the direction of the socket end wall 79, with respect to the "normal" position of the strut groove 92. Thus, when the strut is snapped into assembled position it is automatically pressed toward the bottom of the socket to urge the flat walls 91a and 79 into tight face to face contact.

With reference now to the exploded view of Fig. 17, the reference numeral 70a designates generally a second connector element, identical to the connector element 70, but oriented so that its principal plane lies at right angles to that of the element 70 and also so that its recess side (not shown in Fig. 17) faces the recess 74 of the element 70. When these two elements 70, 70a are moved together, in the direction of the arrow 96, the portion of the connector 70 to the left of the end surface 75 is received by the recess of the connector element 70a. Likewise, the recess 74 of the element 70 receives the right-hand portion of the element 70a. The completed assembly of the two connecting elements 70, 70a is evident in the perspective view of Fig. 17. The assembled connectors provide radially oriented strut-receiving recesses in two planes, so that the structural possibilities of the system are greatly enhanced.

To secure the two connector elements 70, 70a in assembled relation, cooperating ribs and grooves are formed on the respective parts. The guide walls 72, 73 are provided with transverse detent grooves 97. These are arranged to receive appropriately located detent ribs 98 on the opposite connector element. The ribs 98, as indicated in Fig. 17, are formed on the radial spokes 77. During assembly of a pair of connector elements 70, 70a, as the projecting ribs 98 reach the outer end of the guide walls 72, 73, the guide walls are elastically displaced outwardly a distance sufficient to accommodate the presence of the ribs. This elastic displacement is facilitated by providing a small gap 81 in the recess wall 80. Thus, during the assembly process, the opposite halves of the divided wall 80 are displaced toward each other, facilitating the outward displacement of the guide walls 72, 73. This process is happening simultaneously on both of the connector elements 70, 70a, as will be understood.

The single plane connector element described in Figs. 1-5 is formed with a symmetrical array of eight strut-receiving sockets. The individual connector elements 70, 70a, on the other hand, are formed with one less strut-receiving socket, by reason of the open-sided recess 74 at one side of the connector. Nevertheless, when the two elements are assembled, as reflected in Fig. 16, for example, each connector element contributes, in effect, a strut-receiving socket to the other connector element, so that there are four pairs of opposed sockets in each plane.

When two of the connecting elements are assembled in the manner of Fig. 16, three opposed pairs of sockets on each connecting element are open and accessible for lateral insertion of a strut 90. However, the case of one of the opposed pairs of sockets, designated as 83, 83a, normal lateral insertion of a strut is precluded by the immediate adjacency of outwardly extending gripping elements 84 carried by the opposite connecting element of the assembly.

Insertion of a strut element 90 into the partially inaccessible sockets 83, 83a is facilitated by reason of the slotted recess wall 80. The slot 81 therein enables limited outward displacement of the adjacent gripping arms 84 to enable a strut element to be "cammed" into position through a levering motion, illustrated schematically in Figs. 19 and 20.

With reference to Fig. 19, the position of the strut 90 shown in broken lines represents a typical starting position for inserting a strut into a socket 83a of a connecting element 70a. The end surface 100 of the strut is placed against an outer surface 101 of the adjacent gripping arm, and this serves somewhat as a guide as the strut is pushed laterally into the socket, while generally holding the angular orientation shown in Fig. 19. During this operation, there is an initial outward displacement of the opposed gripping arms, accommodated by the slot 81 which tends to open up wider than normal. In addition, the recess guide wall 72 is

deflected outward slightly, and this is encouraged by a levering action of the strut 90 in the direction of the arrow 102 of Fig. 19. This has the effect of prying upwardly against the guide surface 101, so that the adjacent gripping arm 84 is displaced in the direction of the arrow 103 in Fig. 5. Levering of the strut continues until the flanged end of the strut snaps into place in the recess, as shown in full lines in Fig. 19. Removal of a strut from one of the partially blocked recesses 83 or 83a is accomplished by a generally reverse procedure.

As shown in Fig. 31, the configuration of the socket-forming recesses 150 and struts 140 advantageously are such that the center of curvature of the ribs 130, 131 is located on an axis 151 which is offset from the surface 152 of end wall 125 a distance slightly less than the offset between the axis 153, containing the center of curvature of the annular groove 147, and the end surface 154 of the strut element. As a result, when the strut element is forced laterally into gripped position in the recess 150, the ribs 130, 131 are in pressure contact with side portions of the annular groove, in a manner to force the strut end surface 154 into tight face-to-face contact with the surface 152 of the recess end wall. By tightly holding these two surfaces in face-to-face contact, a desirable degree of additional rigidity is imparted to the assembly of the strut and connecting element.

Connector elements may be formed in a wide variety of types and styles, having from one to a plurality of socket-forming recesses 150. Connector elements having more than one recess advantageously are configured so that recesses are separated angularly by 45°, or a multiple thereof, although other configurations are useable within the teachings of the invention.

In Fig. 21, a single recess connector element 160 is illustrated. It includes a hub section 161 defined by a cylindrical wall 162. The inside diameter of the hub cylinder is approximately the diameter of a cylindrical envelope formed by the strut elements 140. The diameter of that cylindrical envelope corresponds to the diameter of the cylindrical end portions 146, 148 of the strut element, and also to the diametric dimensions of the ribs 145. A strut element thus may be freely received in the cylindrical opening 163 of the hub, with a slight clearance to accommodate free rotation and free longitudinal movement of the struts within the hub cylinder. The axis 164 of the hub cylinder is disposed at right angles to the longitudinal axis 165 of the recess 150. The wall 167, which forms the end wall of the recess 150, is spaced from the hub axis 164 by a pair of space web sections 166, which are integral with the wall 167 and the hub cylinder 162.

Typically, the connector elements are constructed of a predetermined, uniform thickness in the direction of the hub axis 164. Preferably, the width is approximately equal to the diameter of the cylindrical envelope of the strut elements. A thickness of approximately 0.244 inch has been found to be particularly desirable, in that it permits, in most cases, connector elements to be assembled side-by-side, cross-ways with respect to a strut, over the full length of the central body of the strut, with virtually no space left at either end. This allows structures to be formed with, in effect, a solid wall of elements joined to a transversely disposed strut across the full width of the body portion of the strut.

The connector device illustrated in Fig. 22 is similar to that shown in Fig. 21, but includes a pair of socket-forming recesses 150 angularly separated by 180°, with the longitudinal axis of the respective socket-forming recesses being coaxially aligned and intersecting with the hub axis 171. The connector element of Fig. 22 is particularly useful for joining a pair of strut elements end to end, in coaxially aligned relation, as reflected in Fig. 30. For this and other reasons, the distance from the hub axis 171 to the outer face of the recess end wall (corresponding to the surface 152 in Fig. 31) is the same for both recesses of the connector element 62 of Fig. 22 as for the single connector element 160 of Fig. 21. This difference is designated by the letter "d" in Figs. 21 and 22. This geometric relationship is also applied to the several varieties of connector elements illustrated herein such that, in all cases, a strut element secured in a socket-forming recess of a connector element is positioned a fixed, predetermined distance from the central hub axis of the connector element.

In the illustration of Fig. 23, a connector element 180 is shown, which also is provided with two socket-forming recesses 150. These are aligned along axes 181 intersecting with a hub axis 182 disposed at right angles thereto. The construction of the hub cylinder, recesses 150, etc. is generally the same as described with respect to the connector elements 160 and 170. However, in the modification of Fig. 23, the strut-receiving recesses 150 are spaced apart by an angle of 45°.

In the connector elements 190, 200 of Figs. 24 and 25 respectively, the connector elements are provided with three and four strut-receiving recesses 150 respectively, in each case arrayed along axes 191, 201 intersecting with a hub axis 192, 202 and angularly spaced 45° apart. As reflected in the views of Figs. 23-25, the connector elements therein shown include intermediate, radially disposed spoke-like walls 183, 193, 203 which extend radially with respect to the hub axes 182, 192, 202 and are joined integrally with end walls of adjacent recesses 150. The outermost walls 184, 194, 204, on the other hand, extend into tangency with the

respective hub cylinders 185, 195, 205.

In the illustrations of Figs. 26-28 connector elements 210, 220, 230 are formed to have, respectively, five, six and seven socket-forming recesses 150, each arrayed along an axis intersecting and extending radially from the hub axis 212, 222, or 232. The several recess axes 211, 221 and 231 are spaced apart at an angular distance of 45°, as in the case of the connectors of Figs. 23-25. Preferably, in each of the connector elements of Fig. 26-28, the exterior wall sections 214, 224, 234 are arranged to be tangent to the hub cylinders 215, 225, 235, for both esthetic and functional purposes. The walls 214 of the connector element 210, for example, in conjunction with the continuing wall of the associated socket-forming recess, provide a broad, flat surface on which to support the connector element and/or a flat surface to define an outer edge of a structure.

The connector element 240 of Fig. 29 is substantially of the configuration shown in Fig. 1, in this instance being formed as part of a series of connector elements of common dimensions. In this respect, the distance "d" from the hub axis 242 to the face of any recess wall is the same uniform distance as in the other illustrated forms of connector elements.

With reference to Figs. 30 and 32, the system of the invention advantageously incorporates strut elements in various graduated lengths, according to a predetermined size progression, such that strut elements of various sizes in a set may be assembled together with the before described connector elements to form a series of right triangular structural units of an assembly. In the composite illustration of Fig. 30, there are shown a series of strut elements 140a-140f, inclusive, of progressively increasing lengths. The progression of lengths is such that when any two strut elements of a given size are joined with a connector element to form two sides of a right triangle, the strut of the next greater length is of the appropriate size to form the hypotenuse of that triangle. For example, in Fig. 32, a three-position, right angle connector element 190 is joined with two strut elements 140a of the smallest size, forming the sides of a right triangle. In the illustration, the vertically oriented strut 140a is joined with a four-position connector element 200 and the horizontally oriented strut element 140a is joined with a five-position connector element 210. A strut element 140b, constituting the next size longer than the connector elements 140a, is joined with the connector elements 200, 210, forming the hypotenuse of a small right triangle.

In the illustration of Fig. 32, the element 140b, which forms the hypotenuse of the first described right angular structural element, designated by the reference numeral 250, itself forms one side of a right triangular structural element 260 of a larger size. In this respect, the connector element 200 is joined with a second strut element 140b to form two sides of the triangle 260. A second four-position connector element 200 is joined to the upper end of the upper strut element 140b, and a strut element 140c, being the third element in the length progression, is joined with the upper connector 200 and the before mentioned connector 210 and constitutes the hypotenuse of the triangular structural element 260. As is evident in Fig. 32, a pair of the strut elements 140c may in turn constitute the sides of a still larger right triangular structural unit 270, the hypotenuse of which is constituted by the next larger size strut element 140d. Progressively larger right triangular structural units may be assembled, within the limits of the maximum length strut element provided by the set.

In the system of the invention, the length progression of the strut elements is in accordance with a predetermined formula. Thus, in a system of "n" different lengths, each strut length is determined according to the formula:

$$L_x = (1.414)^{(x-1)} * D_{min} - (2 * d), \text{ where}$$

L_x = Length of the x^{th} strut of a series of 1 to "n",

D_{min} = the spacing between hub axes of two connector elements joined by the shortest strut element of the series,

d = the distance from the hub axis to the end wall of the socket-forming section.

It is known to assemble structures of right triangular units, including structures in which the hypotenuse of one triangular constitutes a side of a second and larger right triangular unit. In the toy system of the present invention, however, unique advantages are derived from the design of the connector elements and strut elements to accommodate lateral, snap-in assembly of the strut elements into the connectors. This enables parts to be assembled and disassembled from the structure, without involving change of the center-to-center distances between connector elements and connection points. Thus, complex, rigid, multi-dimensional structures can be designed and assembled for great facility.

As shown in Fig. 32, there is also an advantageous geometric relationship between the graduated length strut elements 140a-140f and connector elements in which there are socket-forming recesses oriented 180° apart. This includes in particular the connector element 170 (Fig. 22), which is a two-position connector element having its recesses 150 coaxially aligned and oppositely facing. This connector element serves usefully as a splicing

connector, to join two shorter strut elements to form a longer strut assembly. When one of the connector elements 170 (which may conveniently be referred to as a splice connector) is joined with two struts of a given size. A strut assembly is formed which is equal in length to a strut two sizes larger than the strut elements joined by the splice connector. Thus, as shown in Fig. 32, two of the shortest strut elements 140a are spliced to form a strut assembly equal in length to the strut 140c. Two of the next size strut elements 140b are spliced to form a strut assembly equal in length to the strut 140d. Additional corresponding assemblies are shown in the composite view of Fig. 30. It is possible, of course, to join in a splice connector 170 strut elements of different lengths, in order to develop strut assemblies of a length different from the standard, progressive strut length illustrated in Fig. 30.

Since all of the connector elements, regardless of configuration, employ a common spacing "d" from hub axis to the end surface of the socket-forming recess, the relationships illustrated in Fig. 30 will obtain in any situation in which strut elements are assembled to a connector with a coaxial orientation.

The assembly shown in Figs. 33 and 34 is comprised of a plurality of single recess connector elements 160 (Fig. 21) joined with a plurality of strut elements of a predetermined uniform size, such as elements 140c as reflected in Fig. 30. A first plurality (three in the illustration) of single unit connector elements 160 are arranged in side-by-side relation, spaced apart by the width of a connector element, and are rotatably connected to a strut element, as designated by the reference numeral 280 in Fig. 34. The strut element 280 is passed through the hub opening 281, in which it is freely received. For purposes of identification, the reference numeral 282 is applied to connector elements of the first group. Alternating with the connector elements 282 are similar connecting elements, identified by the reference numeral 283. The connector elements 283 are snap fitted onto the strut element 280, with the rib portions 130, 131 of the connector element tightly received in the grooves 144 of the strut element, so as to tightly grip the strut element. Thus, while the individual connector elements 282 are freely movable with respect to the strut element 280, the alternating connector elements 283 are rigidly secured thereto, both against rotation and sliding movement. A succession of such assemblies provides an articulated beltlike structure, which can be endless in form or of finite length, as desired, and can be of any suitable width for the purpose intended. As shown in Fig. 33, the end extremities of the strut elements project a short distance from each edge of the beltlike assembly.

Structures of the type shown in Figs. 33, 34 have a wide variety of advantageous uses. Among these is the formation of tracks, for track-laying vehicles such as bulldozers, cranes, tanks and the like. Panel-like structures can also be assembled to function, in a toy structure, as wall or roof panels, for example, floor surfacing and the like. A narrow assembly can be utilized as a flexible cable-like element, for example.

With reference now to Figs. 35-41, there is shown a particularly advantageous form of connector element arranged for assembly with another connector element having similar features, to provide a connector assembly providing means for joining strut elements extending in a plurality of planar directions.

The connector elements 310 illustrated in Fig. 35 are formed with four recess positions 150, angularly spaced at 45°. Directly opposite one of the recess positions 150a of each element is positioned a special recess 311. The recess 311 is defined by spaced-apart side walls 312, 313 and a bottom wall 314. The side walls 312, 313 are spaced apart a distance equal to the standard thickness of a connector element and are arranged symmetrically to an imaginary plane extending through the geometric center of the connector element 310 and containing the longitudinal axis of the oppositely oriented strut-receiving recess 150a. The exposed surface of the end wall 314 lies on a plane at right angles to the previously mentioned plane, also passing through the principal axis of the connector, identified by the reference numeral 315.

The connector elements 310 are arranged to be assembled together in the manner reflected in Figs. 35-37, with the respective special recess portions 311 facing each other and the principal planes of the respective connectors being oriented at right angles. The respective connectors 310 are pressed together until the end walls 314 of the recesses 311 are in firm face-to-face contact, so that the respective central axis 315 of each element lie substantially in a common plane.

Desirably, each of the recess walls 312, 313 is formed with a transverse groove 316 arranged to receive, in detent locking relation, ribs 317 projecting from opposite sides of spoke walls 319. Accordingly, when the two elements are assembled together, they are, relatively rigidly locked together against any but intentional separation.

As reflected in Fig. 36, when the walls 312, 313 first engage the projecting ribs 317, the walls are displaced outwardly. The presence of a small gap 318 enables the gripping arms of the opposed strut-receiving recess 150a to be easily displaced toward each other while the walls 312, 313 are being outwardly displaced by the ribs 317. When

the parts are pressed together to their final positions, with the end walls 314 seated against each other, each of the sets of ribs 317 will be seated in each of the sets of recesses 316, substantially as shown in Fig. 37.

The assembled connector elements of Figs. 35-39 provide for the support of strut elements in each of two planar directions disposed at right angles. The connector arrangement thus is perfectly suited assembling external corners of structures, as can be appreciated by observations of Figs. 38 and 39.

In the composite view of Fig. 40, a connector element 310 of the type shown in Figs. 35-39 is arranged to be joined with a second, seven-position connector 410. The connector element 410 includes a special recess 411 disposed coaxially opposite to a strut-receiving recess 150a.

Assembly of the connector elements 310, 410, to form a multi-planar assembly is accomplished in the same manner described with respect to Figs. 35-39. The resulting assembly is of Tee-shaped configuration when viewed from above, as reflected in Fig. 41, and provides for the mounting of strut elements in each of three planar directions. In the Tee-shaped assembly of Figs. 40, 41, the upper socket position 150a is not accessible for normal, lateral snap-in assembly of a strut element, because of the presence of the associated connector element. However, by providing the gap 318 in the recess end wall, it becomes possible to insert the strut initially at an angle and to install it by a twisting motion, all as hereinbefore described. The gap 318 allows the gripping arms 16 to more easily separate, in order to accommodate a twist-in assembly of the strut.

For certain applications, however, it may be desired to lock a connector element together with a strut passing through its central hub opening, for rotation in unison and/or for fixing the position of the connector element axially along the strut element. To this end, the system includes a drive element, such as illustrated in Figs. 42-44 of the drawing, for frictionally and non-rotatably gripping a strut element. In the illustrated form, the drive element comprises a drive block 510, injection molded of suitable plastic material and advantageously incorporating a socket-forming recess 150 of the form previously described. This includes particularly the opposed projecting ribs 130, 131 defining a narrow throat area between the gripping arms 16. Adjacent the closed end of the recess 150, the block 510 advantageously mounts a driving lug 511 projecting laterally from one end face 512, generally parallel to the alignment of the ribs 130, 131.

In a typical utilization of the drive block 510, a connecting element 240, typically of a full "snowflake" configuration, having eight strut-receiving positions, is mounted on a strut 513. The drive block 510 is applied to the body portion of the strut 513, so that the respective ribs 130, 131 are received in and lockingly engaged with opposed longitudinal grooves 144 of the strut. The block 510 is thus rigidly fixed to the strut against rotation and also is frictionally restrained against longitudinal movement along the strut (being slidable thereallong, however, under appropriate force).

The location of the drive lug 511 is such that, when the connector element 240 and drive block 510 are directly adjacent each other, the drive lug 511 is positioned in and substantially occupies the trapezoidal space between a pair of adjacent, radially disposed spoke-like walls 123. The strut 513 and connector element 240 are thus locked against relative rotation, so that rotational drive applied to one of the elements is correspondingly imparted to the other. By positioning drive blocks 510 on opposite sides of a connector element, the connector element can be locked in position, axially on a strut.

For many dynamic toy assemblies, drive pulleys and/or wheels are useful and desirable elements. To advantage, a combined pulley/wheel element 610 is shown in Fig. 45. This is an injection molded part formed with an outer rim 611 and a central hub opening 612 adapted to be closely received over a strut element. Radially outward from the central opening 612 are one or more drive recesses 613. These are arranged to receive the drive lug 511 of a drive block (Fig. 42). As shown in Fig. 47, the element 610 is provided with an external annular recess 614, which enables the element to function as a pulley, when associated with an appropriate drive belt (not shown). When the element 610 functions as a pulley, it is drivingly connected to a strut element, using a drive block 510, functioning either as a drive pulley or a driven pulley, as the case may be.

The element 610 can be covered to form a wheel by applying the tire element of Fig. 46. The tire element, designated generally by the numeral 620, is formed of a resilient elastomer, such as neoprene. The inner portion 621 of the tire is of a width to be closely received in the annular recess 614. The outer portion 622 of the tire is wider than the inner portion 621, advantageously equal in width to the thickness of the outer rim portion 611 of the wheel element 610. Shoulders 623 are formed at each side of the tire. These engage outer flanges 624 of the wheel element 610, to position the tire concentrically on the supporting rim.

When used as a wheel, the element 610 may be driven or not, as desired. If it is to be driven, then a drive block 510 is employed, as previously described.

The construction toy system of the invention provides a uniquely simplified, yet exceptionally versatile construction medium, for assembling a limitless variety of structures, both static and dynamic in character. The system easily lends itself to the production, by economical, mass production injection molding techniques of standardized building elements of a wide variety, permitting the relatively quick and simplified assembly of structures.

Within the basic concepts of the invention, it is possible to construct simplified and effective forms of dynamic structures, such as endless tracks or belts, driven rotating systems and the like. These are achieved with the consistent use of standardized strut elements and standardized connecting elements. That is, the connecting elements utilize standardized socket-forming recesses, although various in number, and such recesses are located at standardized distances from the principal axis of the connecting element. Likewise, the strut elements incorporate standard end configurations, in conjunction with body portions of various length. Further, by providing for a splice connector, capable of joining two strut elements end to end, the structural combinations available from a relatively limited number of standardized strut lengths is multiplied.

The elements of the construction toy of the invention are adapted readily for high production injection molding of the component parts of a suitable plastic material. A variety of such plastic materials are suitable for the purpose, it being necessary, of course, to select a material having a reasonable degree of strength and elasticity to enable proper functioning of the gripping arms, for example, over numerous assembly and disassembly operations. A material known to be suitable for the purpose is "Celcon M270", an acetal copolymer made available by Hoechst Celanese, Chatham, New Jersey.

By enabling the hub-like connector elements to be joined with structural elements by a lateral snap-together action, it becomes more practical to assemble large and complex structures, because the center-to-center distance between component elements does not have to be altered during joining of the components. By contrast, where assembly of the components requires axial insertion of one part into another, center-to-center distances are temporarily enlarged, which at best requires great care and at worst may make it impossible to assemble certain types of structures.

The arrangement of the invention provides a unique two-way gripping action between the hub-like connector elements and the structural elements, wherein the outer, deflectable portions of the gripping arms 76 provide lateral containment, while the innermost portions of the gripping arms form a relatively non-deflectable flange-receiving cavity which freely admits the end flange 86 of the structural element during lateral assembly, but provides positive restraint against axial movement of the structural element.

Claims

1. A construction toy system of the type comprising a plurality of connector elements and a plurality of structural elements adapted to be removably engaged with said connector elements to form a composite structure, wherein
   (a) each connector element having at least one open-ended recess for receiving and retaining a structural element by its end,
   (b) each said recess having an inner end wall and a pair of spaced-apart gripping arms defining an axis extending between said side walls,
   (c) integral locking projection means extending inwardly from at least one of and preferably both of said gripping arms,
   (d) said locking projection means being spaced from said inner end wall and defining with said end wall a first locking chamber,
   (e) said gripping arms being formed with concave grooves therein extending from said locking projection means toward the open end of said recess,
   (f) said concave grooves being generally coaxial with said axis, and an opposed pair of said grooves defining a second locking chamber,
   (g) at least one end portion of said structural elements being shaped to be confined within a generally cylindrical envelope,
   (h) said end portion defining an axis of said structural element and having a locking flange at the end extremity, receivable laterally within said first locking chamber and being locked therein against movement in the direction of the axis of said structural element,
   (i) said end portion further having an annular groove immediately adjacent and partly defining said locking flange,
   (j) said annular groove being adapted to receive said locking projection means when said structural element is inserted laterally into said open ended recess,
   (k) said concave grooves being shaped and positioned to closely receive portions of the cylindrical envelope of said structural element, and (l) said gripping arms being elastically deflectable to accommodate lateral insertion of said structural element into said

recess.

2. A construction toy system according to claim 1, further characterized by,
(a) said structural elements having a generally circular cross section in the region of the end extremities thereof,
(b) the spacing between pairs of gripping arms being less than the diameter of said circular cross section,
(c) the contours of the concave recesses of said gripping arms corresponding generally to the circular contours of said structural elements.

3. A construction toy system according to claim 2, further characterized by,
(a) a portion of said hub-like connector element extending between the gripping arms of each pair at their inner ends and defining with said gripping arms a generally U-shaped recess for the lateral reception of an end portion of a structural element,
(b) The cross sectional configuration of said recess, taken along its longitudinal axis, and in a plane bisecting said gripping arms, being generally in close conformity to the longitudinal cross sectional configuration of an end portion of a structural element.

4. A construction toy system according to claim 1, further characterized by,
(a) said locking projection means being of arcuate convex configuration and extending generally from one edge of a gripping arm to the other,
(b) the annular groove in said structural element having a cross sectional configuration to closely receive said locking projections, whereby said structural element is thereby locked against separation from said connector element in the direction of the axis of said structural element.

5. A construction toy system according to claim 1, further characterized by,
(a) said structural elements being of generally circular cross section over at least a portion of their length,
(b) said structural elements being of generally "X" cross section, within the envelope of said generally circular cross section, over at least a portion of their length,
(c) said portions of generally "X" cross section being receivable in the space between a pair of said gripping arms while said structural elements are disposed at right angles to the axis of said gripping arms,
(d) said structural element being adapted to be forced laterally between a pair of opposed locking projections on said gripping arms and being thereby lockingly gripped by said projections.

6. A construction toy system according to claim 1, further characterized by
(a) opposed locking projections on said gripping arms extending transversely thereto and extending into the space between said gripping arms,
(b) said strut element having an end flange defined in part by said annular groove and a flat end face spaced from said groove,
(c) said annular groove and said locking projections, and said end wall and said flat end face, being so geometrically related that, when said strut element is assembled in said socket, the flat end face of said strut element is urged firmly and resiliently in an axial direction into face to face contact with said end wall.

7. A construction toy system according to Claim 1, further characterized by said connector element having
(a) a central core defining a central axis of said connector element,
(b) a plurality of strut-receiving sockets arranged generally radially about said core,
(c) said core and sockets forming a connector of generally flat configuration and of predetermined thickness,
(d) an open-sided recess in one side of said connector element, extending to said central axis and having a width equal to the thickness of the connector element,
(e) said open-sided recess being adapted to receive a second connector element to form a composite connector element having strut-receiving sockets radiating in two planes.

8. A construction toy system according to claim 7, further characterized by,
(a) said connector having a strut-receiving socket directly opposite said open sided recess whereby, in an assembly of first and second joined connector elements, the second connector element has a strut-receiving socket at the location of the open-sided recess in the first connector element.

9. A construction toy system according to claim 7, further characterized by,
(a) said open-sided recess being defined by a pair of spaced-apart, parallel guide walls

for receiving the second connector element, said guide walls having detent means therein cooperating with detent means on the second connector element to retain an assembled pair of connector elements in joined relation.

10. A construction toy system according to Claim 9, further characterized by

(a) said connector element having a plurality of sockets, each comprised of a pair of gripping arms and a end wall,

(b) the end walls of adjacent sockets being adjacent and integrally joined, and

(c) at least one of said end walls being slotted to form a gap, to accommodate outward deflection of said guide walls during assembly of first and second connector elements prior to engagement of said detent means.

11. A construction toy system according to claim 10, further characterized by,

(a) said connector element having a strut-receiving socket located directly opposite said open-sided recess, and

(b) said last mentioned socket having said slotted end wall.

12. A construction toy system according to claim 11, further characterized by,

(a) said sockets being configured for lateral, snap-in reception of end portions of said struts, and

(b) the gripping arms of said last mentioned socket being separable upon displacement of the parts of said slotted end wall, to accommodate assembly of a strut by other than lateral, snap-in reception.

13. A construction toy system according to claim 7, further characterized by,

(a) said open sided recess having detent means of a first type therein, and

(b) portions of said connector element located diametrically opposite said open sided recess being formed with detent means of a second type engageable with detent means of said first type for lockingly engaging a pair of connector elements in assembled relation.

14. A construction toy system according to claim 7, further characterized by,

(a) said connector element having a plurality of sockets, each comprised of a pair of gripping arms and a end wall,

(b) the end walls of adjacent sockets being adjacent and integrally joined,

(c) at least one of said sockets being arranged directly opposite to said open-sided recess, and

(c) the balance of said sockets being arrayed on the same side of the plane containing said open-sided recess and said one socket,

(d) whereby, when said connector element is joined with a second connector element, said second connector element having a plane containing the axes of its sockets, the sockets of the first connector element project in the plane of and/or on one side of the plane of the second connector element.

15. A construction toy system according to claim 14, further characterized by,

(a) the first connector element being configured with one socket directly opposite to said open-sided recess and all other sockets on one side of a plane containing said one socket and said recess and disposed at right angles to the plane of said first connector element.

16. A construction toy system according to claim 15, further characterized by,

(a) said second connector element being configured the same as the first connector element,

(b) whereby a connected pair of said connector elements define a right angle corner structure.

17. A construction toy system according to claim 15, further characterized by,

(a) said second connector element being configured with sockets extending in an array of greater than 180°,

(b) whereby a connected pair of said first and second connector elements define a Tee-shaped joint structure.

18. A construction toy system of the type comprising a plurality of connector elements and rod-like strut elements formed of molded plastic material and removably joinable with other elements to form a coherent structure, wherein at least certain of the connector elements comprise

(a) a socket-forming section disposed on a predetermined socket axis,

(b) said socket-forming section comprising a pair of spaced-apart, generally parallel cantilever mounted gripping arms symmetrically arranged with respect to said socket axis,

(c) said gripping arms being formed with

first interlock means to interlock with a strut element for releasably but firmly holding a strut element aligned with said socket axis,
(d) second interlock means formed in said socket-forming section to interlock with a strut element for releasably but firmly holding a strut element in a predetermined axial position along said socket axis,
and wherein at least certain of said strut elements comprise
(e) elongated rod-like members formed with opposite end portions and intermediate portions integrally joining said end portions,
(f) said opposite end portions being provided with first and second interlocking means for cooperative engagement with the first and second interlocking means of said connector element, whereby the respective first interlocking means hold a strut element in coaxial alignment with said socket axis and the respective second interlocking means hold a strut element in predetermined axial position on said socket axis,
(g) each pair of gripping arms defining between them an open-sided, axially disposed socket, and
(h) said arms being resiliently separable to accommodate lateral snap-in reception of an end portion of a strut element in a direction transverse to said socket axis, whereby said strut element is firmly spaced and positioned in fixed relation to said socket-forming section.

19. A construction toy system according to claim 18, further characterized by
(a) said second interlocking means comprising opposed rib-like elements on said spaced-apart gripping arms, and conforming groove means on the opposite end portions of said strut elements,
(b) said rib-like elements being oriented transversely to said socket axis to receive said conforming groove means during lateral reception of an end portion between a pair of gripping arms.

20. A construction toy system according to claim 19, further characterized by,
(a) said socket-forming section including an end wall integral with said gripping arms and spaced from said rib-like elements,
(b) said strut elements having end surfaces spaced from said conforming groove means,
(c) the spacing between said rib-like elements and said end wall being such, in relation to the spacing between said conforming groove means and said end surface, that said end wall and end surface are urged into snug contact when said strut element is received in said socket-forming section.

21. A construction toy system according to claim 18, further characterized by,
(a) said second interlocking means comprising rib-like interlocking means on one of said socket-forming section or said strut element, and conforming groove means on the other of said section or element.

22. A construction toy system according to claim 21, further characterized by,
(a) said socket-forming section having a closed end formed by an end wall,
(b) said strut element having an end surface,
(c) said second interlock means yieldably urging said end surface into snug contact with said end wall.

23. A construction toy system according to claim 18, further characterized by,
(a) said connector element including a hub-forming section having a transverse opening therein of a size and shape for the axial reception of a strut element and defining a hub axis,
(b) said hub axis being disposed at right angles to and substantially intersecting with said socket axis, and
(c) said connector element comprising a single socket-forming section integrally associated with a single hub-forming section.

24. A construction toy system according to claim 23, further characterized by,
(a) said connector element comprising a pair of socket-forming sections integrally associated with a single hub-forming section,
(b) said socket-forming sections being oppositely disposed and being aligned along a common socket axis.

25. A construction toy system according to claim 23, further characterized by,
(a) said connector element comprising a plurality of "n" socket-forming sections,
(b) each of said socket-forming sections being aligned along respective socket axes disposed approximately 45° with respect to a neighboring socket axis and all of said axes intersecting each other substantially at said hub axis,
(c) where "n" is an integer between 2 and

8.

26. A construction toy system according to claims 24 or 25, further characterized by,

(a) each of said socket-forming sections being disposed at a fixed predetermined distance from said hub axis,

(b) whereby, when a strut element is retained in any socket-forming section, the end extremity of said strut element is spaced a fixed, uniform distance from said hub axis.

27. A construction toy system according to claim 26, further characterized by,

(a) said system including a series of strut elements of graduated lengths, and wherein

(b) in a system of "n" different lengths, each strut length is determined according to the formula

$L_x = (1.414)^{(x-1)} * D_{min} - (2 * d)$, where

L_x =
Length of the x^{th} strut of a series of 1 to "n",

D_{min} =
the spacing between hub axes of two connector elements joined by the shortest strut element of the series,

d =
the distance from the hub axis to the end wall of the socket-forming section,

(c) a plurality of connector elements and strut elements of said system being adapted to be assembled into one or more right triangles.

28. A construction toy system according to claim 27, further characterized by,

(a) an assembly, comprising a connector element of claim 33, joined with two strut elements of length L_x in a series, being equal in length to a strut element of length $L_{(x+2)}$ in said series.

29. A construction toy system according to claim 18, further characterized by,

(a) said gripping arms being formed with rib-like projections extending transverse with respect to the socket axis and projecting inward toward the socket axis,

(b) said strut element being formed, in a predetermined area between its end, with opposed longitudinally extending grooves,

(c) said strut element being yieldably received in said socket in an orientation disposed at 90° to the socket axis, with said rib-like projections being received in an opposed pair of said grooves,

(d) whereby said strut element is non-rotatably gripped by said connector element with said strut element disposed parallel to said hub axis.

30. A construction toy system according to claim 29, further characterized by,

(a) said connector element including a hub-forming section having a transverse opening therein of a size and shape for the axial reception of a strut element and defining a hub axis,

(b) said hub axis being disposed at right angles to and substantially intersecting with said socket axis, wherein

(c) a plurality of such connector elements are joined to form a belt-like structure,

(d) a first group of such connector elements being arranged in side-by-side relation, spaced apart by a distance at least equal to the width of a connector element,

(e) the hub axes of each of the elements of said first group being coaxially aligned,

(f) a first strut element extending through the hubs of each of the connector elements of said first group,

(g) a second group of such connector elements being arranged in side-by side relation, and interspersed in the spaces between connector elements of the first group,

(h) the connector elements of the second group gripping said first strut element by engagement of the rib-like projections of the connector elements with an opposed pair of longitudinal grooves of said first strut element, and

(i) additional groups of such connector elements and struts connected in an extended series to form an articulated belt-like structure.

31. A construction toy system according to claim 29, further characterized by,

(a) said strut elements being of such length, in relation to the combined width of said first and second groups of connector elements, that end portions of said strut elements project laterally from each side of the assembly.

32. A construction toy system according to claim 28, further characterized by,

(a) said connector element being formed with an integral, laterally extending drive lug,

(b) said connector element being mounted on a strut element with the rib-like projections of said connector element being received in opposed grooves of said strut element whereby said connector element is locked in fixed relation to said strut element,
(c) an additional element rotatably mounted on said strut element,
(d) said additional element being positioned adjacent to said connector element,
(e) said drive lug being in driving engagement with an adjacent portion of said additional element, whereby said additional element can drive or be driven by said strut element.

33. A construction toy system according to claim 32, further characterized by
(a) said additional element comprising a circular wheel-like element having a rim portion and a hub portion,
(b) said hub portion having an hub opening for receiving said strut element,
(c) said wheel-like element having a drive opening located a predetermined distance radially outward from the center of said hub portion, for the reception of the drive lug of said connector element,
(d) said wheel-like element having an outwardly facing annular groove in said rim portion.

34. A construction toy system according to claim 33, further characterized by
(a) an annular tire-like element formed of elastomeric material and removably received in said annular groove.

35. An adaptor element for use in interfacing the construction toy of claim 1 with a building block set of the type comprising a hollow molded building block element of rectangular configuration, provided with a top wall and four side walls defining an open cavity, a plurality of regularly spaced circular projections extending upward from the top wall, and a plurality of internal projections extending from said top wall into said cavity and toward the open side thereof, which adaptor element comprises,
(a) a hollow molded adaptor block of rectangular configuration having one open side,
(b) said hollow molded adaptor block having a top wall and four side walls,
(c) the internal surfaces of said side walls closely circumscribing an area occupied by a predetermined plurality of circular projections of said building block element, whereby said side walls can be snugly engaged internally by said circular projections,
(d) said hollow molded adaptor block having a plurality of elongated, cylindrical projections extending from its closed side,
(e) said cylindrical projections having a length substantially greater than their diameter,
(f) spaced-apart pairs of said elongated projections being separated from each other by a distance approximately equal to twice the thickness of the side walls of said building block elements, whereby a pair of said elongated projections, when inserted into the open sides of two adjacent building block elements, secure said elements together and to the adaptor element,
(g) said adaptor element having a hollow tubular internal projection extending from its top wall substantially to its open side and being of an internal diameter to closely receive an end extremity of one of said structural elements.

36. An adaptor block according to claim 35, further characterized by,
(a) said adaptor block being of a width corresponding to the width of at least certain ones of said building block elements, and
(b) said elongated projections being receivable internally of said certain building block elements and gripped therein.

FIG. 1.

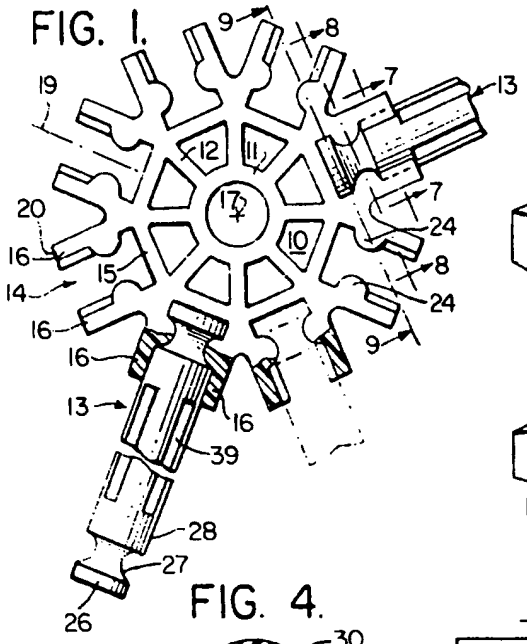


FIG. 2.

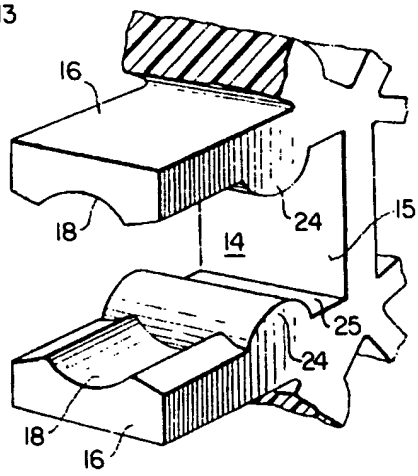


FIG. 4.

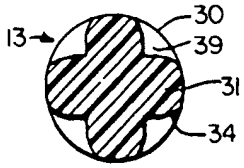


FIG. 3.

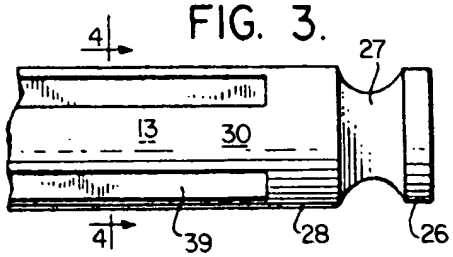


FIG. 5.

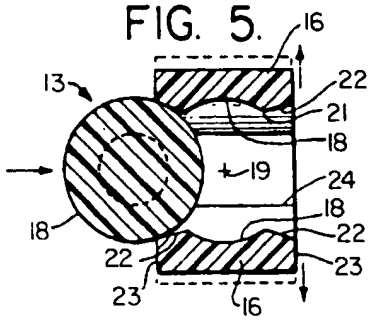


FIG. 6.

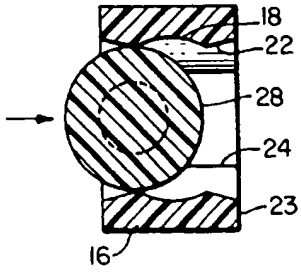


FIG. 7.

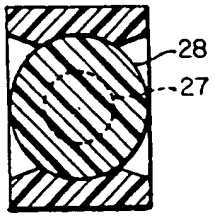


FIG. 8.

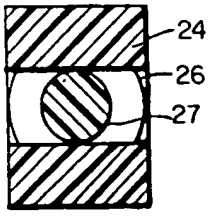


FIG. 9.

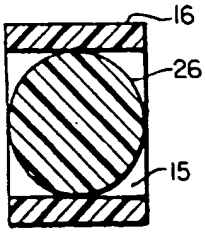


FIG. 10.

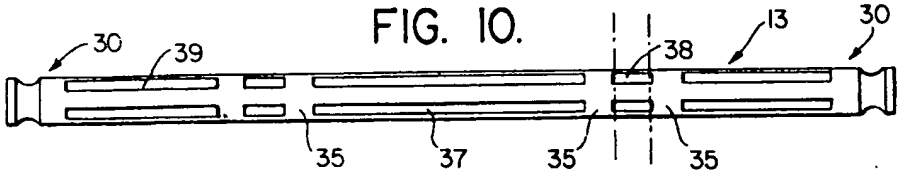


FIG. 11.

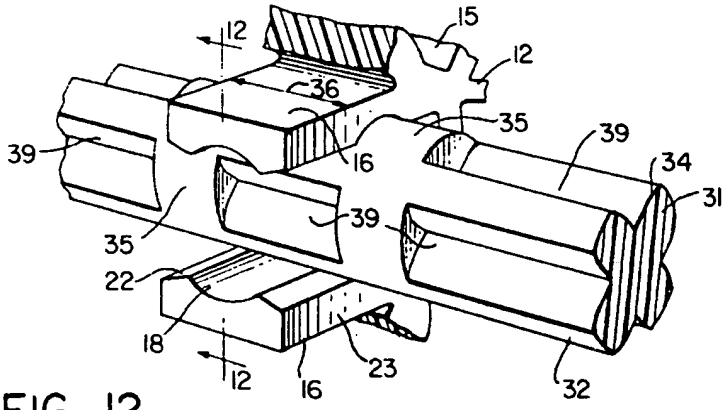


FIG. 12.

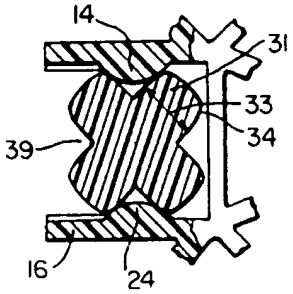


FIG. 13.

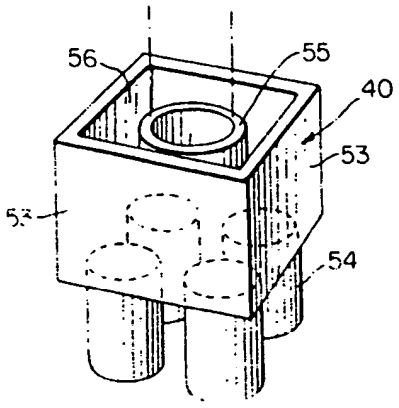


FIG. 14.

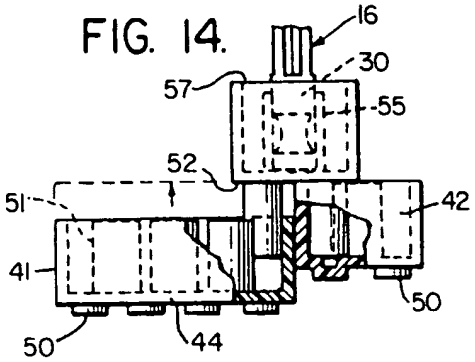


FIG. 15.

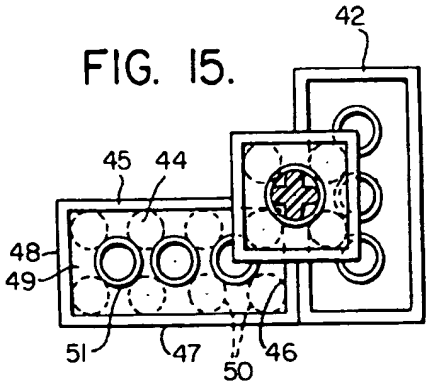
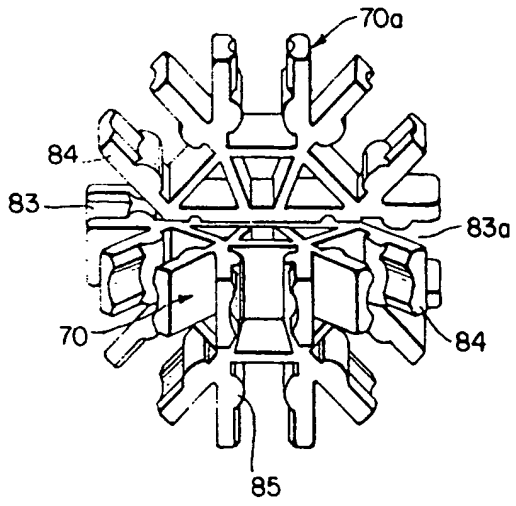


FIG. 16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83a
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FIG. 17

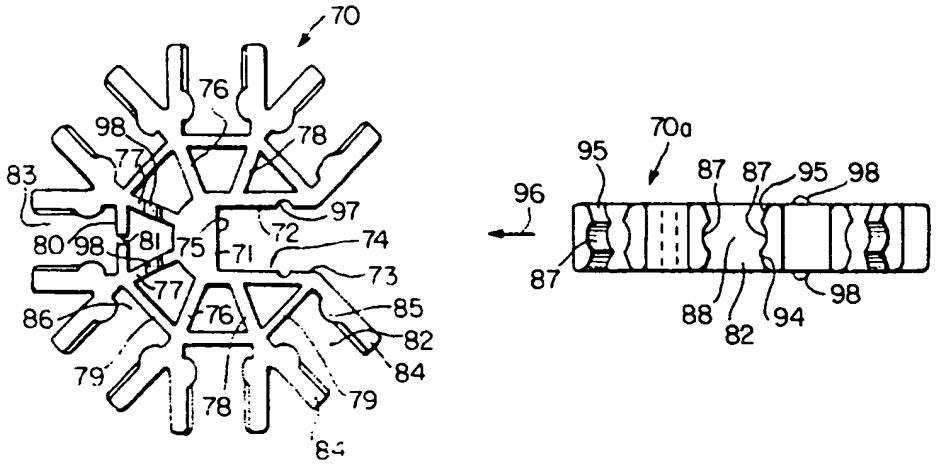
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FIG. 18

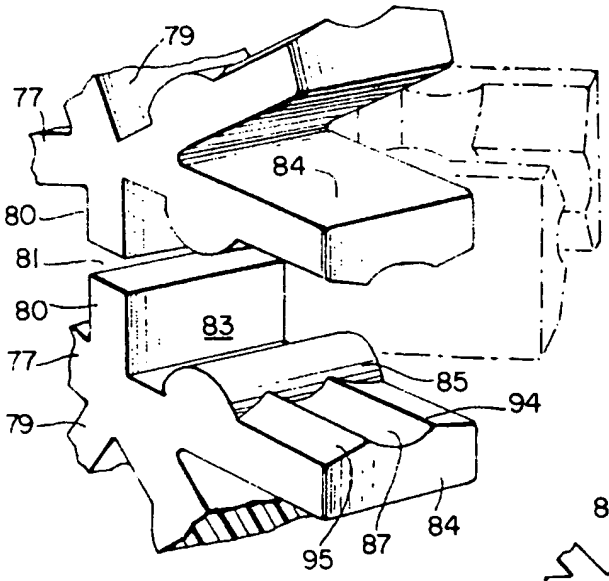

FIG. 20

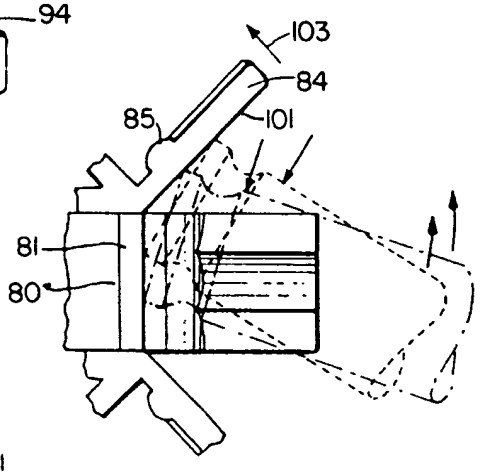

FIG. 19

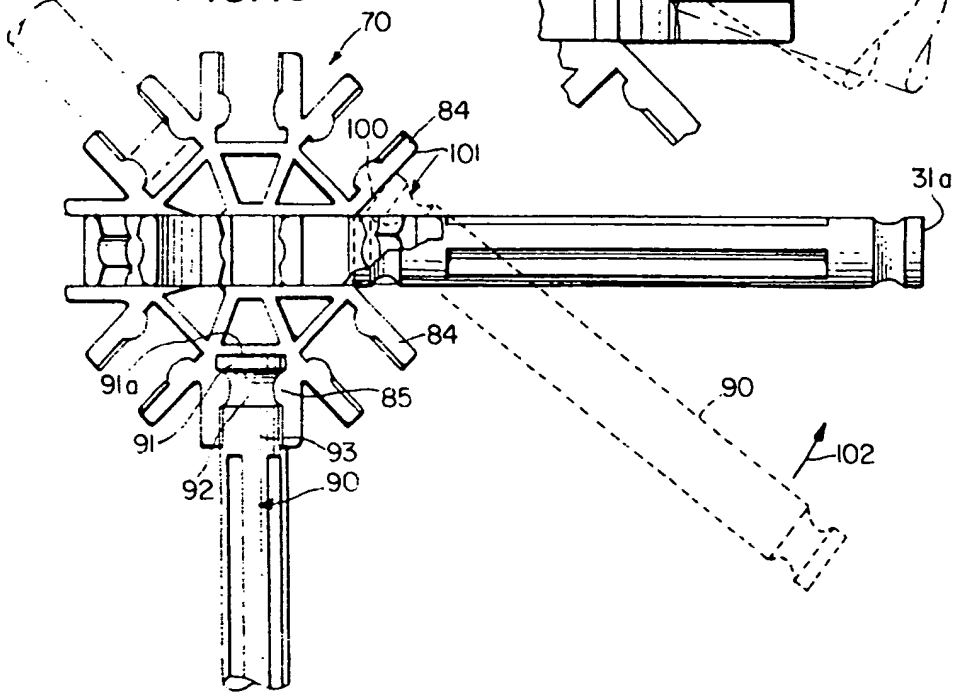

FIG. 21

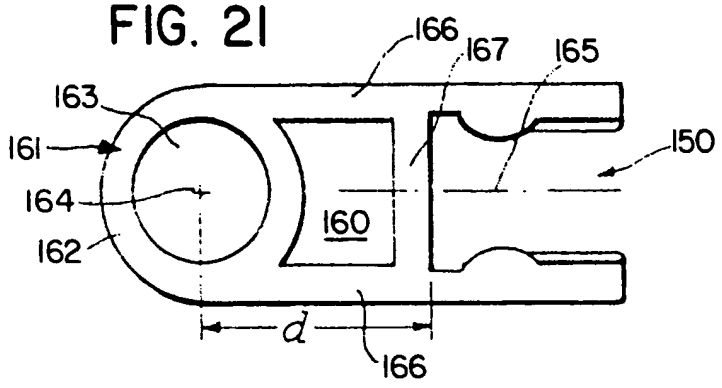

FIG. 22

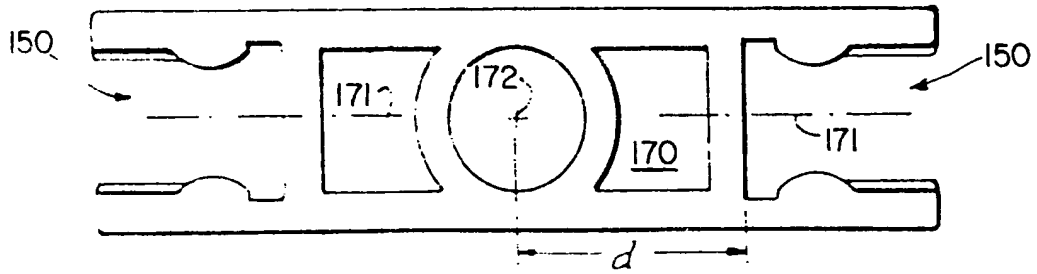

FIG. 23

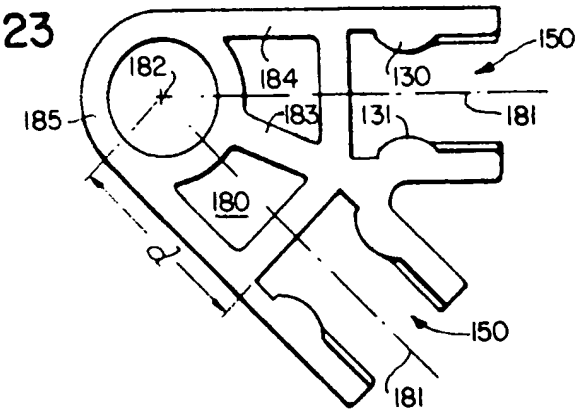

FIG. 24

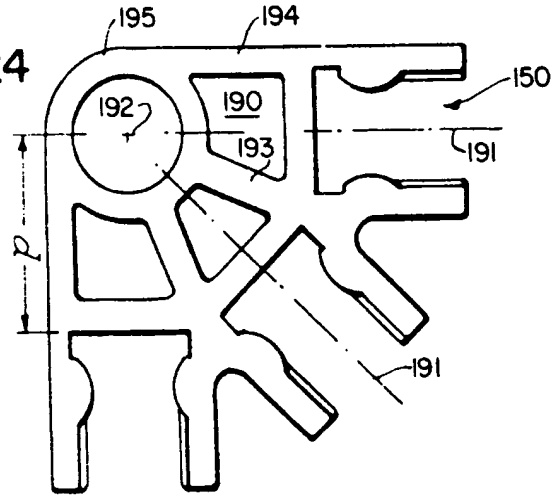

FIG. 25

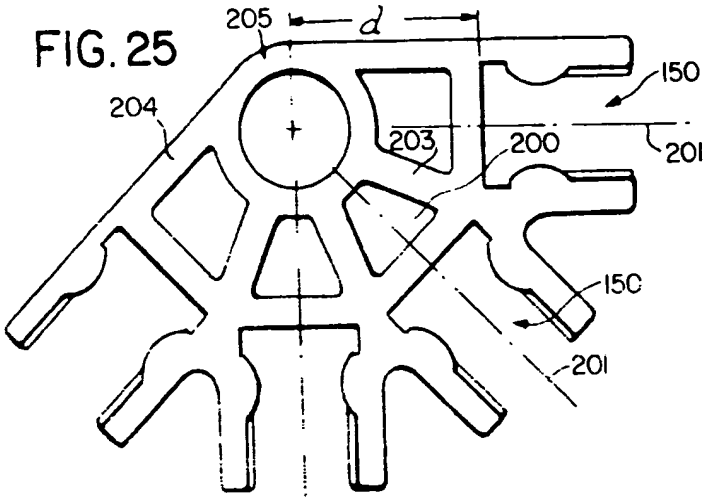

FIG. 26

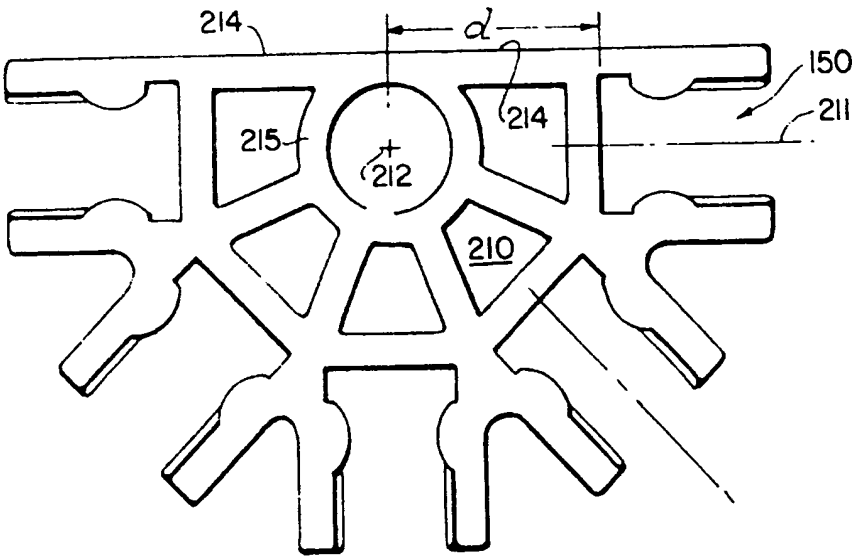

FIG. 27

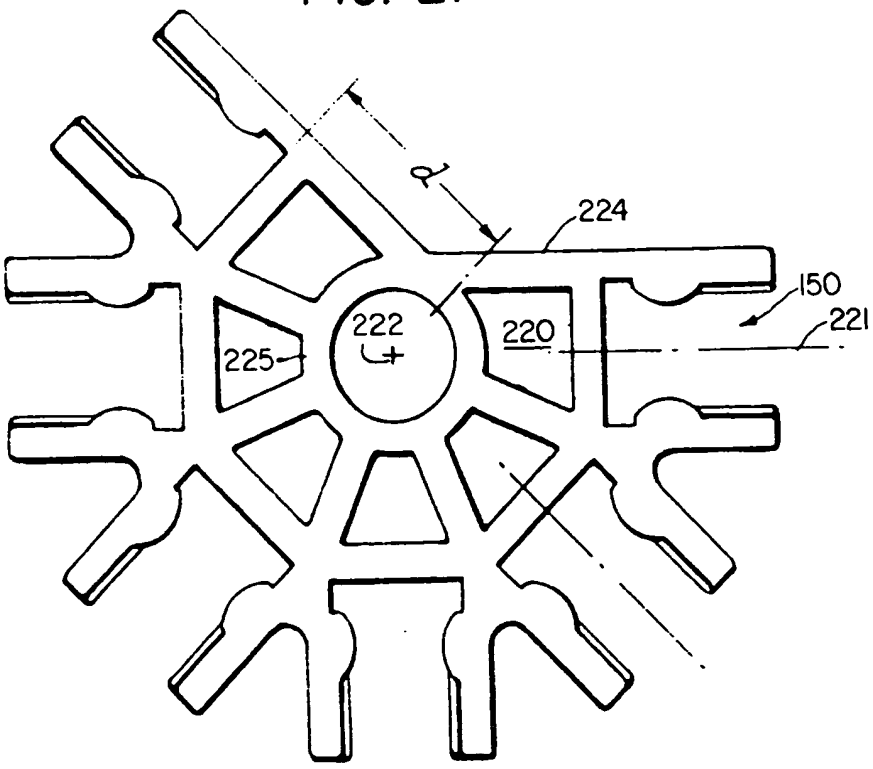

FIG. 28

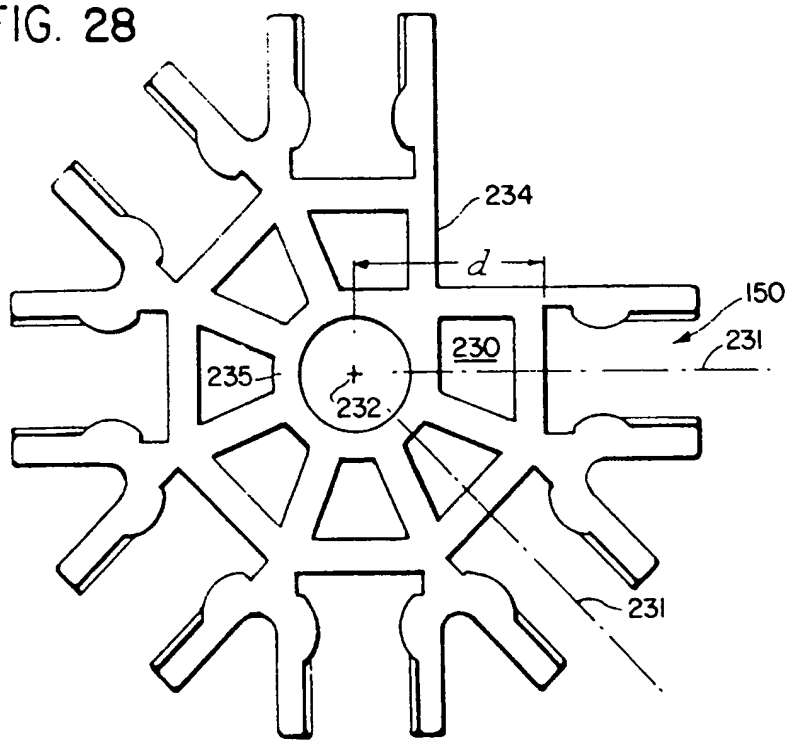

FIG. 29

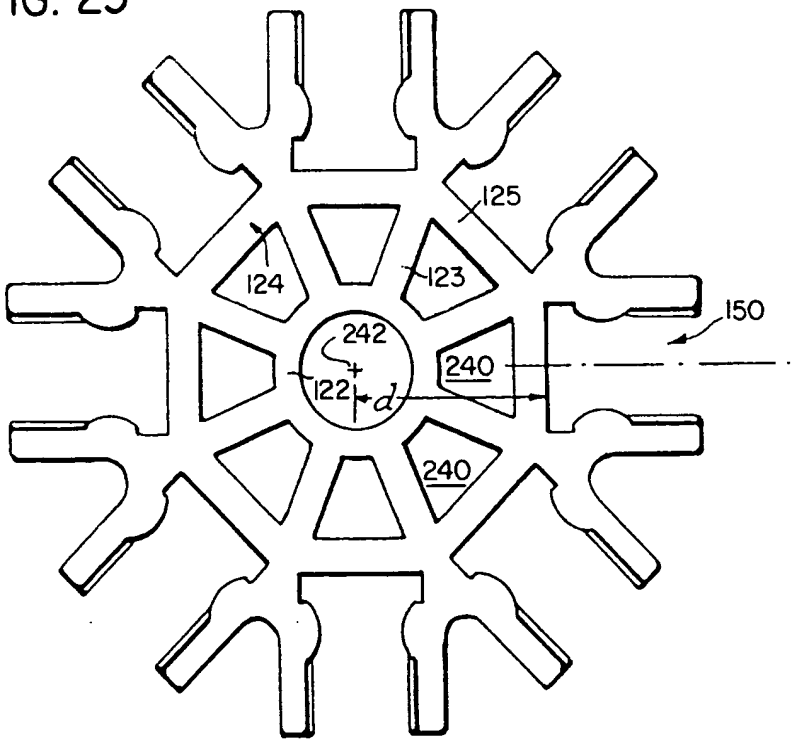

FIG. 30

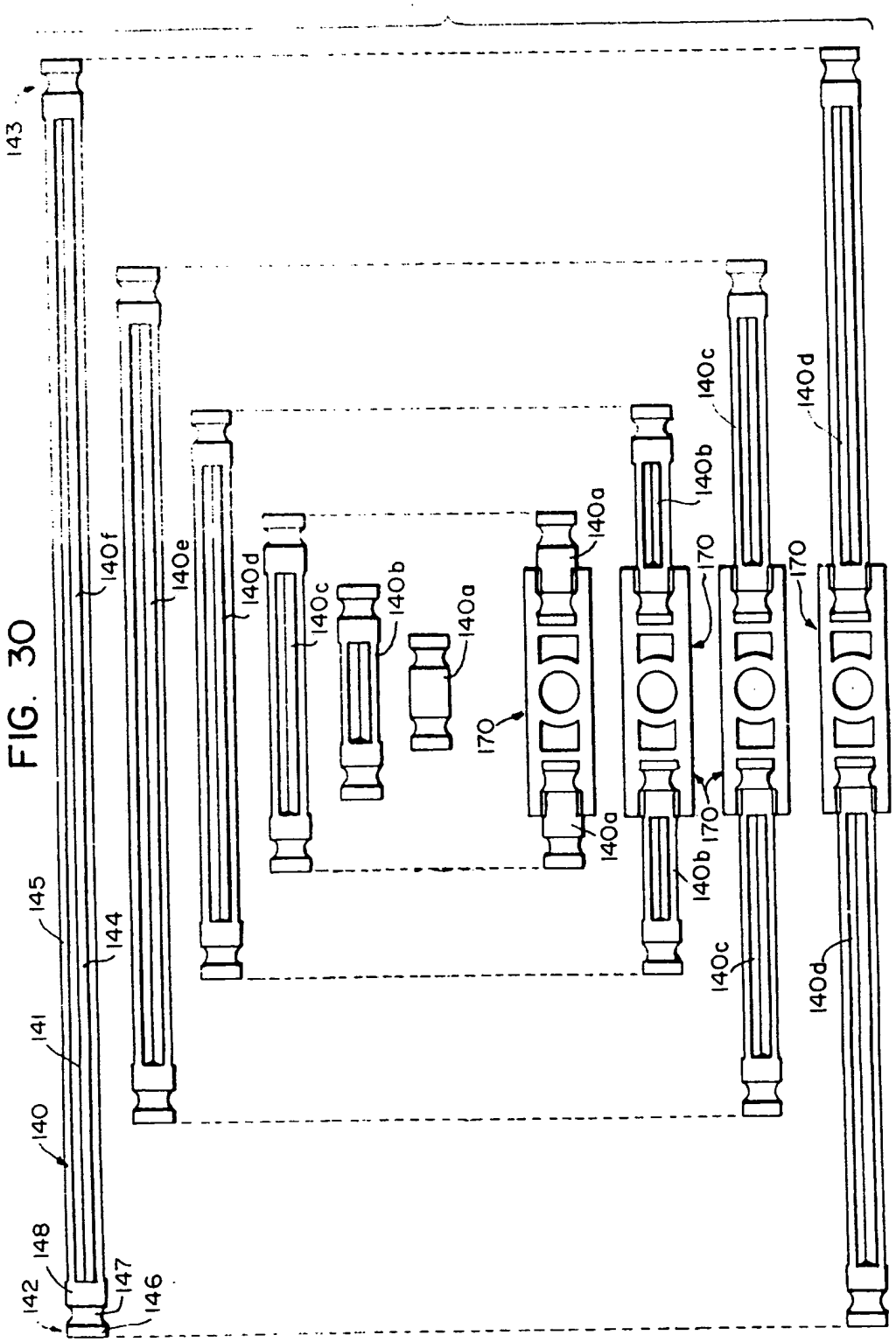
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FIG. 31

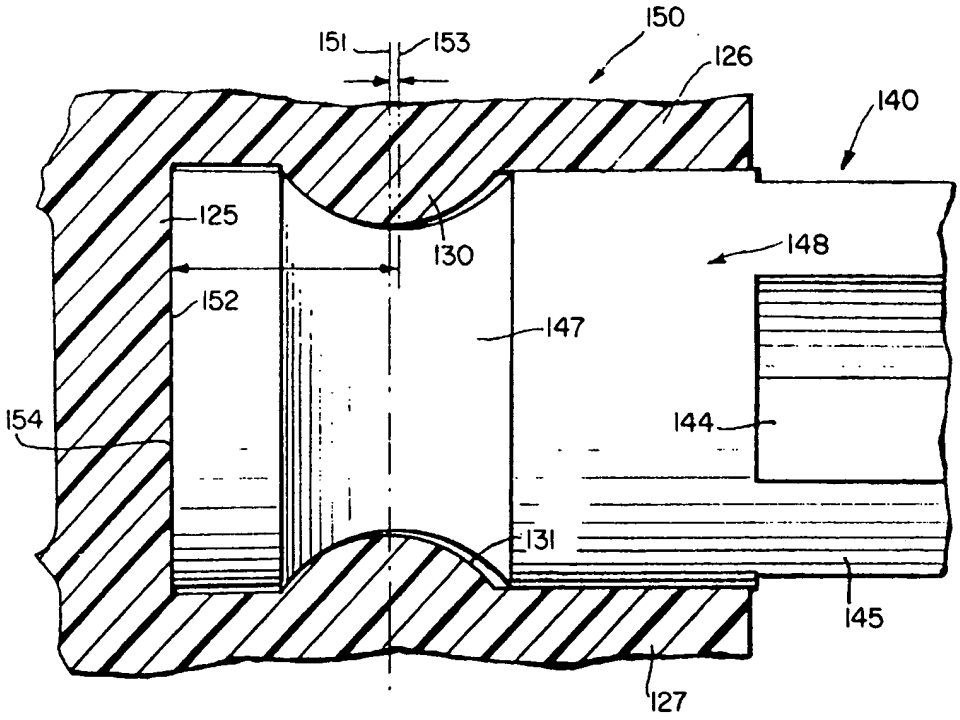
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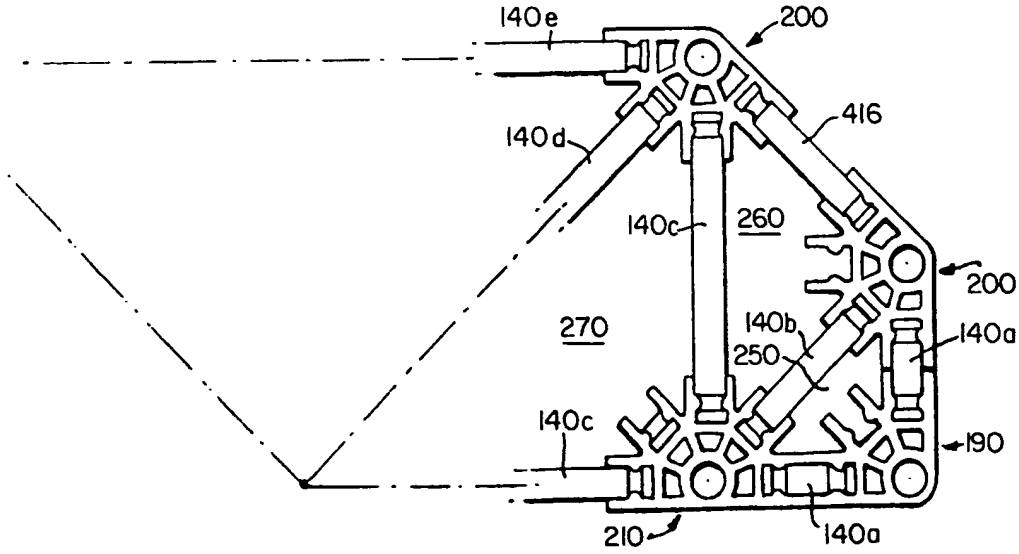
FIG. 32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140c
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FIG. 33

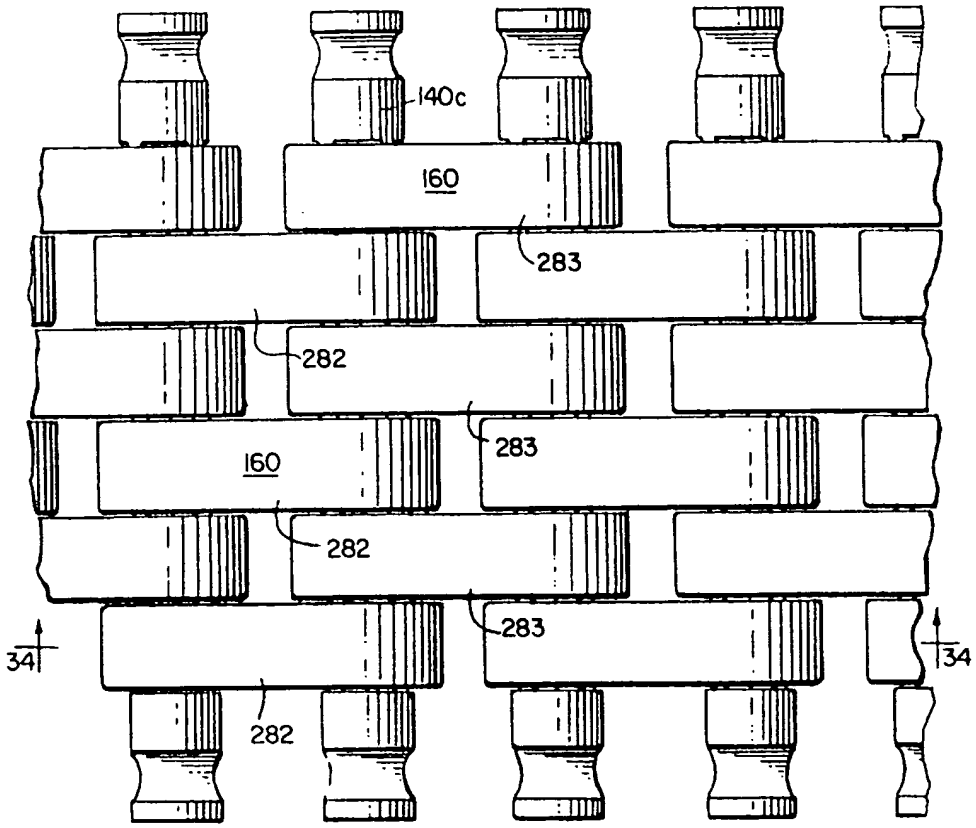
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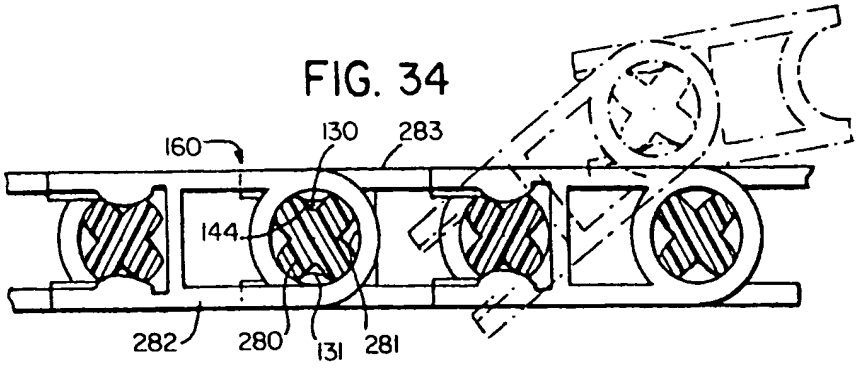
FIG. 34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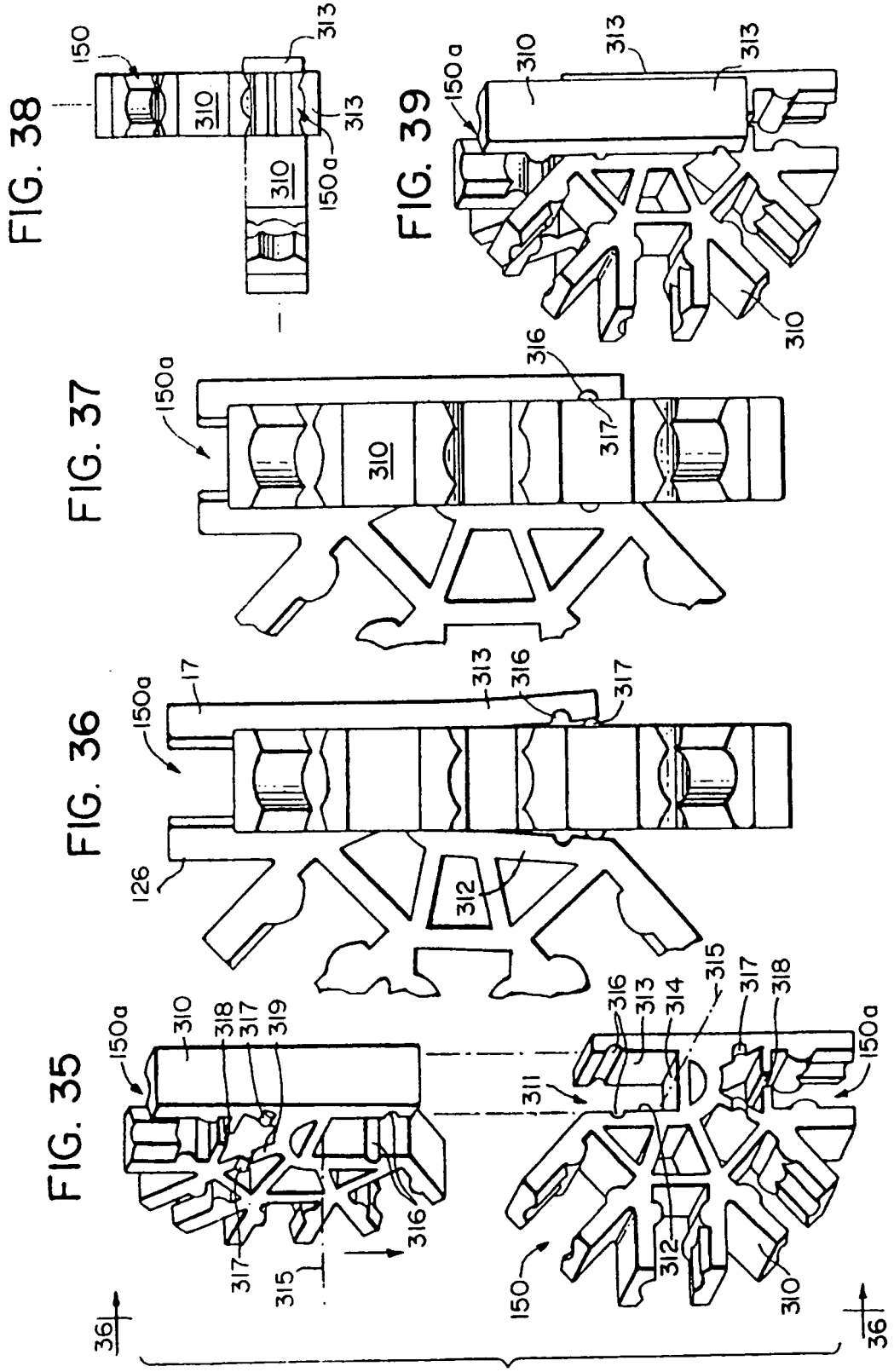
FIG. 38
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FIG. 39
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FIG. 37
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FIG. 36
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FIG. 35
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FIG. 43

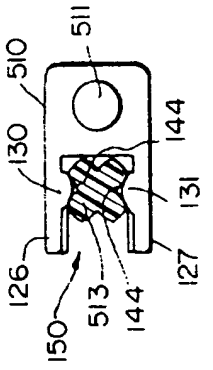


FIG. 44

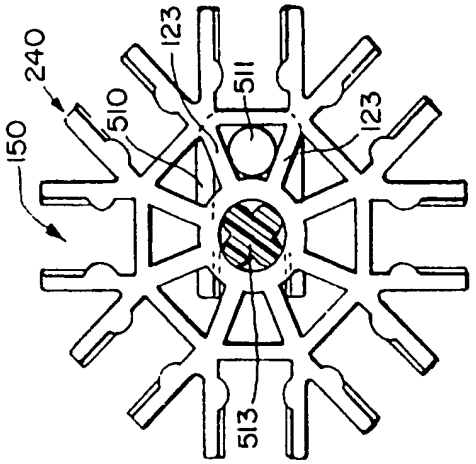


FIG. 41

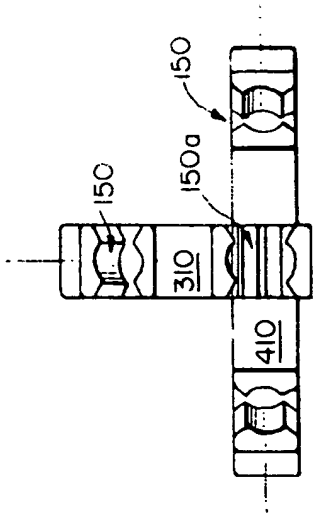


FIG. 42

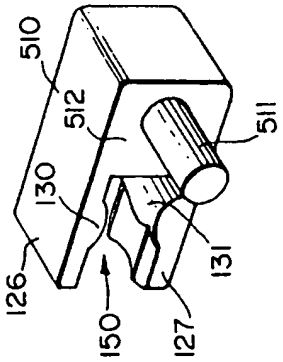


FIG. 40

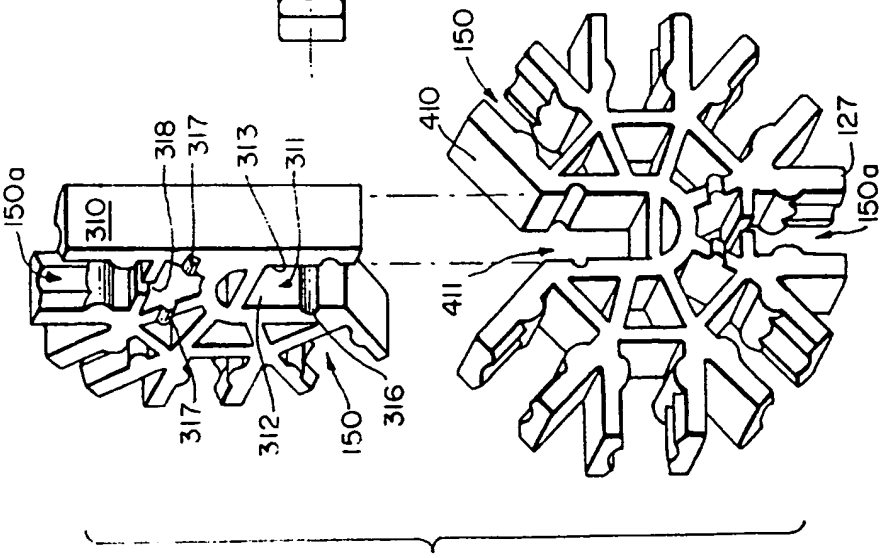


FIG. 47

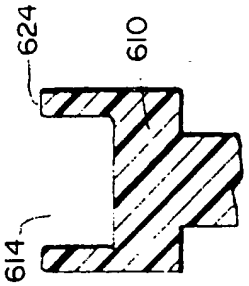


FIG. 48

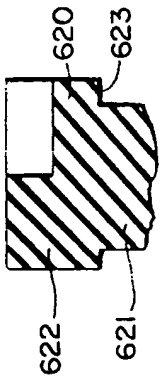


FIG. 45

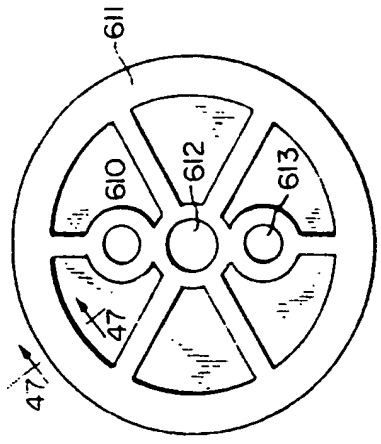
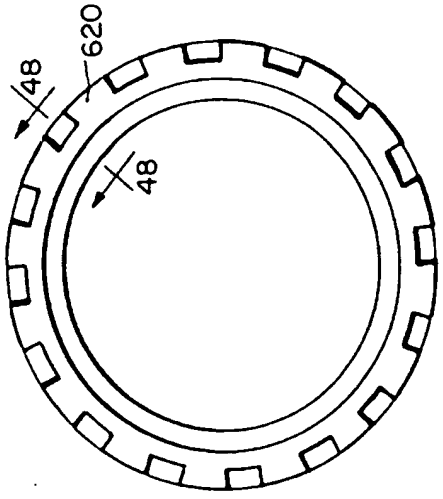


FIG. 46



European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 91 11 6255

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	FR-A-1 475 308 (FISCHER) * page 2, column 1, lines 18-50; abstract; figures 1,7,8 *	1-3,7-18	A 63 H 33/08
A	DE-A-3 524 467 (BERNDT) * page 10, line 5 - page 12, line 25; figures 1a,b *	1,18-23	
A	GB-A- 866 557 (INTERLEGO) * page 2, lines 79-109; figures 1-5 *	1,18,35,36	
A	US-A-2 633 662 (NELSON) * column 1, line 29 - column 2, line 33; figures 1-3 *	1,18	
A	EP-A-0 284 311 (T.-H. WANG) * column 2, lines 18-54; column 3, line 58 - column 4, line 21; figures 9,10 *	1,18	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

A 63 H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	16-03-1992	MONNE E.M.B.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
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P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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